Economic and Life Cycle Assessment of integrated wood and chips harvesting from hybrid poplar plantations in the Genil Valley (Spain). Comparison with chips harvesting from Poplar SRCs

Rubén Laina, Eduardo Tolosana, Sara J. Herrero
INTRODUCTION

• Fast growing rate, resistance to frost, re-sprouting capacity (buscar datos europeos)

• Roundwood combined with chips production is currently a sustainable activity. 90 thousands ha poplar plantations

• Could poplar SRC be a profitable alternative in abandoned farm-land?

• SRC is still a “promise” (all SRC for bioenergy are a promise in Spain), subsidies cutback, investment barriers, electricity consumptions decreasing, ¿heat production?
INTRODUCTION

Integrated plantations Vs Short Rotation Coppice

• Stake holders

Environmental impact
• Everybody
• Policy makers
• Scientist

Economic analysis
• Landowner
• Logging companies
• Scientist

Environmental and economic analysis of wood and chips from poplar plantation
INTRODUCTION

• Goals
  ➢ To identify phases to improve according results of LCA and economic analysis
  ➢ To compare chips production from integrated and SRC alternative
Methodology

Life cycle assessment

Simapro Recipe

Funcional unit: hectare

Economic analysis

NPV and IRR

“Funcional unit: €/ha”

Environmental and economic analysis of wood and chips from poplar plantation
Methodology

LOCATION

Data from a time study, local landowners and logging companies.
### Methodology System boundaries

<table>
<thead>
<tr>
<th>Integrated system</th>
<th>Poplar SRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wood &amp; Chips</td>
<td>• Chips</td>
</tr>
<tr>
<td>• 10 year</td>
<td>• 3+3+3+3 years</td>
</tr>
<tr>
<td>• Yield (tops and branches 3.6 o.d.t /ha year)</td>
<td>• 17.9 o.d.t /year ha</td>
</tr>
<tr>
<td>• From plantation to mill</td>
<td>• From plantation to mill</td>
</tr>
</tbody>
</table>
### METHODOLOGY SYSTEM BOUNDARIES

#### Harvesting description

<table>
<thead>
<tr>
<th>Integrated</th>
<th>SRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Chainsaw+light backhoe excavator with processing head</td>
<td>• Claas Jaguar chip forager</td>
</tr>
</tbody>
</table>
Methodology system boundaries: Harvesting description

Integrated

- Telescopic boom loader for piling
- Chipper attached to tractor Pezzolato PTH 480/660
- Loading and transport 25 km semi-trailer truck

SRC

- Unloading over a trailer + farm tractor
- Loading and transport 25 km semi-trailer truck
Normalized analysis of the environmental performance of poplar plantation for wood and chips
**Results and discussion**

**MARINE ECOTOXICITY**

- Fertilization: 19
- Weeding: 5
- Stump removal: 5
- Soil preparation: 1
- Plantation: 3
- Pruning: 1
- Irrigation: 0
- Harvesting: 61
- Transport: 5

Simapro 3.0 Model: USES-LCA 2.0 (Huijbregts et al., 2005)
HARVESTING
MARINE ECOTOXICITY KG 1,4-DB- EQ

Disposal, nickel smelter slag, 0% water, to residual material landfill/CH U
Disposal, sulfidic tailings, off-site/GLO U
Phosphoric acid, fertiliser grade, 70% in H2O, at plant/MA U
Disposal, spoil from lignite mining, in surface landfill/GLO U
Disposal, spoil from coal mining, in surface landfill/GLO U

Piling and chipping 47% of contribution
Results and discussion

Environmental impact

Logs 83%

Chips 17%

Mass criteria allocation

Environmental and economic analysis of wood and chips from poplar plantation
Environmental comparison *Integrated Vs SRC*

Functional unit: dried tonnes

<table>
<thead>
<tr>
<th>Environmental Impact</th>
<th>Ratio SRC/Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td>2.2</td>
</tr>
<tr>
<td>Terrestrial acidification</td>
<td>5.0</td>
</tr>
<tr>
<td>Freshwater eutrophication</td>
<td>3.0</td>
</tr>
<tr>
<td>Marine eutrophication</td>
<td>20.3</td>
</tr>
<tr>
<td>Human toxicity</td>
<td>2.0</td>
</tr>
<tr>
<td>Photochemical oxidant formation</td>
<td>1.4</td>
</tr>
<tr>
<td>Particulate matter formation</td>
<td>2.6</td>
</tr>
<tr>
<td>Terrestrial ecotoxicity</td>
<td>4.0</td>
</tr>
<tr>
<td>Freshwater ecotoxicity</td>
<td>2.7</td>
</tr>
<tr>
<td>Marine ecotoxicity</td>
<td>1.2</td>
</tr>
<tr>
<td>Water depletion</td>
<td>4.0</td>
</tr>
<tr>
<td>Metal depletion</td>
<td>0.8</td>
</tr>
<tr>
<td>Fossil depletion</td>
<td>2.9</td>
</tr>
</tbody>
</table>
Results and discussion

Economic analysis

AGREGATED AND "FUTURE" VALUES (€)

-9 521
-2 313
-2 028
-3 737
-1 147
-889
-1 781
-3 714
-463
24 173
3 285
Results and discussion

Economic comparison

Units: €

<table>
<thead>
<tr>
<th></th>
<th>Integrated</th>
<th>SRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operational cost</td>
<td>-23,569</td>
<td>-29,860</td>
</tr>
<tr>
<td>Roundwood selling</td>
<td>24.173,50</td>
<td>0</td>
</tr>
<tr>
<td>Chips selling</td>
<td>3.285</td>
<td>18.098,60</td>
</tr>
<tr>
<td>Annualized NPV (€·ha⁻¹·year⁻¹)</td>
<td>271</td>
<td>-719</td>
</tr>
<tr>
<td>IRR (%)</td>
<td>7.30%</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Harvesting & Transport

<table>
<thead>
<tr>
<th></th>
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<th>SRC</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>3.714</td>
<td>8.399</td>
</tr>
</tbody>
</table>
CONCLUSIONS

• It is important to remark than “fertilization” showed strong influence in environmental issues but does not in economic balance.

• Irrigation phase has strong contribution to environmental and economic performance and it is a difference with northern European countries.

• Harvesting phase is the most important one for environmental impact and the third one in economic analysis. Hence, the process optimization efforts should be addressed to the harvesting operations, which mechanization degree is low.

• Integrated roundwood and woodchips harvesting show less environmental impacts and better economic results that poplar energy crops.
THANKS FOR YOUR ATTENTION

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